

# Biology Major Self-Study

## Evolutionary Biology Named Option

## Neurobiology Named Option

## Plant Biology Named Option

Date submitted:	February 1, 2019
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Departments/Academic Units:	Department of Bacteriology Department of Integrative Biology
School(s)/Colleges:	College of Agricultural and Life Sciences College of Letters and Science

### A. Response to previous program review recommendations

The last 10-year review of the Biology major was in 2011. The program review committee noted a number of concerns related to the fact that the administrative structure, resources, and various practices had not kept pace with the explosive growth of the major, which was, at that point, the largest on campus with approximately 1200 students. The committee made multiple recommendations in 6 areas: administrative structure and home, advising, curriculum, resources, alumni relations, and community connections. In response to these recommendations, major changes in the organization and administration of the major have taken place in the intervening years. In 2013, the Biology major moved from the Institute for Biology Education (IBE) to two departments (Bacteriology and Zoology, now Integrative Biology) within the College of Agricultural and Life Sciences (CALs) and the College of Letters and Science (L&S). An implementation plan (<http://biologymajor.webhosting.cals.wisc.edu/wp-content/uploads/sites/130/2013/10/Detailed-Plan-for-Implementation-of-the-Proposal.pdf>) was developed to clearly spell out the duties of each department and the supervisory structure for personnel, as well as the role of the co-Chairs and Program Committee. As part of the move, the colleges committed new resources to the Biology Major Program: the major gained additional FTEs for advising and program management; physical space was provided in a central location in the Microbial Sciences Building for the advising team; and additional funds were provided for compensation for co-Chairs, as well as a small, dedicated budget for office supplies and staff development. All have had a positive impact on the Major, to the point that many of the previous concerns have disappeared. However, the many changes the Biology major experienced over this period, as well as continued growth of the major through 2016 (to approximately 1500 students), consumed a great deal of time and attention, and relatively little progress has been made in the area of alumni relations.

Major changes in each area in response to recommendations:

*Administrative structure and home:* The transition to a new administrative structure required cooperation and investments from multiple shareholders across campus. The new administrative structure appears to be working well, with an effective supervisory structure, a clear division of duties between the Dept. of Bacteriology and the Dept. of Integrative Biology, and a clear path of approval for curricular changes.

*Advising:* All students now have access to professional staff advisors, and we have achieved the target advisor:advisee ratio of approximately 1:300 when fully staffed.

*Resources:* The program has benefited greatly from increased resources made available during the reorganization. In particular, the increase in FTEs for advisors and the addition of a Biology Program Manager has transformed the program into a highly functional, cohesive student services unit. The program has also benefited from the release time and funds provided to increase compensation for the co-Chairs and has made good use of the funds provided to support staff professional development. However, additional resources may be needed to support activities and follow up on recommendations in some areas where less progress has been made, i.e. alumni relations and community building (see below).

*Alumni relations:* The Biology Major Program still lacks a concrete connection to alumni and alumni donations. The Program Committee has discussed but has not undertaken any organized fundraising efforts. This is partly because other activities related to the reorganization of the major have taken precedence and partly because of lack of experience in this area. The program would benefit from additional help and guidance from the departments, colleges, and the Wisconsin Foundation and Alumni Association.

*Community connections:* Building a sense of community for such a large number of students is a challenge that the program has struggled, and continues to struggle, with. This problem is at least partially due to the lack of programming funds and faculty/staff time to support such efforts. One positive step has been the institution of a pre-graduation reception attended by graduating seniors and their families. A weekly newsletter provides students with valuable information related to the major. Because our students have such diverse interests, it is difficult to imagine that any single extracurricular club, workshop or seminar series could satisfy their needs. Instead, we have looked to the rich array of campus programs and organizations to provide valuable extracurricular experiences.

*Curriculum:* Many changes have taken place at the campus level that have alleviated some of the concerns articulated in the previous review. Increasing numbers of freshmen are now entering or placing out of one or more semesters of Introductory Biology, and the Guide now serves as a central clearing house for course descriptions. One concrete step the Program Committee has taken since the previous review was to expand lab course options by reviewing existing lab courses to identify those offering substantive experiences in 2 hours per week. The program has also worked with instructors in several departments to expand the number of

Capstone course offerings to alleviate a potential bottleneck to graduation for those receiving CALS degrees.

## **B. Overview of the Program**

The Biology Major is designed for students who are interested in a broad exposure to the concepts and methodologies of the biological sciences. In addition, the Evolutionary Biology, Neurobiology, and Plant Biology named options allow students interested in a more specific sub-discipline to concentrate their studies in one of these areas and to have this reflected on their transcript. The major is available to students in both the College of Agricultural and Life Sciences (CALS; administered by the Department of Bacteriology under the B.S. degree) and Letters and Science (L&S; administered by the Department of Integrative Biology under the B.S. and B.A. degrees) with common learning outcomes and curriculum for major requirements, but separate college requirements specific to each degree. The major learning outcomes are as follows:

1. Know and understand core concepts that unify the breadth of biological sciences including: evolution; structure and function; information flow, exchange, and storage; pathways for transformations of energy and matter; and systems.
2. Demonstrate practical skills of a professional biologist including: problem-solving by engaging the process of science; written and verbal proficiency; laboratory skills; quantitative analysis skills; and teamwork skills.
3. Graduates will be able to engage and make broader connections to other scientific disciplines and society.

Current major and degree requirements are available at

<http://guide.wisc.edu/undergraduate/agricultural-life-sciences/bacteriology/biology-bs/#requirementstext> (CALS) and <http://guide.wisc.edu/undergraduate/letters-science/integrative-biology/biology-bs/#requirementstext> (L&S).

The Biology Major serves the mission of the University of Wisconsin-Madison to “provide a learning environment in which faculty, staff and students can discover, examine critically, preserve and transmit the knowledge” through “broad and balanced academic programs” (<https://www.wisc.edu/about/mission/>). Through varied college and degree requirements and biological science requirements encompassing the spectrum from sub-cellular to ecology, the Biology Major provides “a liberal arts education that is both broad and deep” (<http://ls.wisc.edu/about/mission>). As a major that supports broad exposure to the concepts and methodologies of the biological sciences, the Biology Major supports the CALS mission “to advance and share knowledge, discover solutions and promote opportunities in food and agriculture, bioenergy, health, the environment and human well-being” (<https://cals.wisc.edu/about-cals/initiatives/strategic-plan/strategic-framework-documents/>).

All students completing the Biology Major are exposed to the spectrum of biology by choosing courses from different curricular categories; namely, cellular/subcellular biology, organismal biology, ecology, evolution and systematics, and applied biology. Named options provide a filter through which to be exposed to these areas. Courses in the Plant Biology named option focus on plants in each of the categories. Students completing the Evolutionary Biology named option have additional required credits in ecology, evolution, and systematics, but still study biology at the cellular, subcellular, or organismal levels. The now-suspended Neurobiology named option focused studies on the cellular, subcellular, or organismal levels of neurobiology with some exposure to ecology, evolution, and systematics. The growth of available neurobiological coursework and the general popularity of the Neurobiology named option lead to the creation of the Neurobiology Major in Fall 2016. Consequently, the named option in Neurobiology suspended admissions effective Summer 2016 and will be discontinued effective Fall 2019.

In addition to the Biology Major and the new Neurobiology Major, the Department of Integrative Biology also houses the Zoology Major and the Molecular Biology Major. Each of these majors has similar requirements in math, chemistry, introductory biology, and physics. Requirements for intermediate and advanced biological science coursework from several course subjects are tailored to the focus of the individual major. Of the four majors, the Biology Major provides students with the broadest exposure to the biological sciences from small to large scale, across all the domains of life. The Department of Integrative Biology maintains the Biology subject listing.

The Microbiology Major and the Biology Major are the two cross-college (CALs and L&S) undergraduate majors in the Department of Bacteriology. Again, these majors have similar requirements in math, chemistry, introductory biology, and physics, but diverge at the intermediate/advanced level, with biological science coursework requirements from several course subjects, each tailored to the focus of the major. The Biology Major provides students with a broader exposure to the biological sciences from small to large scale, across all the domains of life. The Department of Bacteriology has the lead role in administering the Biology Major through provision of advising space in the Microbial Sciences Building, human resources, and information technology.

The Biology Major Program Committee (BMPC) governs the major as outlined in the bylaws established in 2013. The BMPC is structured as follows:

- The two co-chairs of the Biology Major, one from CALs and one from L&S
- The chairs of the Bacteriology and Integrative Biology curriculum committees, or their designees (ex officio)
- One representative from each Named Option within the Biology Major
- The program manager of the Biology Major (ex officio);
- Three to six elected members, with representation across campus

Current BMPC committee members can be found at:

<https://biologymajor.wisc.edu/administration/>. This committee structure has worked well to allow input from the administrative homes of the major as well as faculty and academic staff interested in the biological sciences from across campus. The BMPC meets monthly throughout the academic year. Three subcommittees meet regularly for in-depth work and planning: curriculum, assessment, and strategic planning and community building. Using a structure of both large and small group meetings has allowed faculty and academic staff, including advisors, to be actively involved in planning and decision making for the major. Decisions regarding specific sections of the Guide- curriculum, learning outcomes, how to get in, and four-year plans- are routed through the two administrative homes of the major via Lumen.

The major has been fortunate to have dedicated, hard-working individuals providing leadership and oversight in their roles as CALS and L&S co-chairs. Biology Major co-chairs must either be tenured faculty in Bacteriology or Integrative Biology or have a formalized relationship with one of those departments. Since 2013, the CALS chair has been selected from candidates within the Department of Bacteriology who have shown commitment to undergraduate instruction and/or curriculum development and have expressed interest in taking on an increased commitment in serving the Biology Major. In L&S, a long-standing advocate of the major was granted affiliate status in the Department of Integrative Biology in order to continue in the role as co-chair following the re-organization of the major. A salary base adjustment equivalent to one month of salary, plus teaching release from one course (or its equivalent in research funds), is provided to compensate the co-chairs. This compensation is important in recognizing the time and administrative effort of the current co-chairs as well as in attracting future co-chairs. Both Microbiology and Integrative Biology have large numbers of faculty who are heavily involved in undergraduate education, increasing the chances of recruiting future effective co-chairs. The faculty serving as elected members of the BMPC are also well-positioned to serve as future co-chairs of the major.

The co-chairs along with the program manager form the leadership team that accomplishes day-to-day administration of the major. The leadership team meets weekly to approve exception and capstone requests, review thesis and independent study proposals, set BMPC meeting agendas, and to discuss timely and pertinent issues related to the major.

### **C. Program Assessment and Evaluation**

Biology Major students achieve learning outcomes through a combination of lecture and lab-based instruction, as well as research experiences such as mentored independent study, CURE courses (course-based undergraduate research experiences where neither instructor nor students know answers to questions investigated), and meta-analysis or literature review. The BMPC supports innovation in biology education by maintaining a wide-ranging curriculum that can accommodate newly developed and experimental courses that increase opportunities for Biology Major students to participate in high impact practices. Among recent additions to the curriculum are Plant Pathology 315: Plant Microbiomes and Genetics, where students engage in

analyzing results of citizen science, and Genetics 527: Developmental Genetics for Conservation and Regeneration, where students select real-life term projects.

According to the Wisconsin Experience Report supplement (<https://apir.wisc.edu/students/wisconsin-experience/>), 100% of Biology majors graduating in 2017-2018 had participated in at least one high impact learning experience. Thirty-two percent had taken at least one honors course and 26% had participated in Study Abroad programs. In the Biocore honors sequence, which requires a multi-semester commitment, 24% of students enter with a declared Biology major. Each year since academic year 2009-2010, the Biology Major has graduated 100 or more students with distinction (GPAs within the top 20% of the students graduating that term in their college/school). At least 20 Biology Major students have earned Honors in the Major, Honors in Liberal Arts or Honors in Research each year over the same time period. All CALS students complete a capstone experience either through an approved course or independent research. Approximately 80% of L&S students have done research for credit in recent years (2012-2018).

The Biology Major submitted its first annual assessment report to the Office of the Provost in November 2018. The report indirectly assessed the learning outcome *“Graduates will be able to engage and make broader connections to other scientific disciplines and society.”* Using responses to selected 2017 National Survey of Student Engagement (NSSE) questions, we found that students are achieving the outcome at a 72% rate. No statistical difference was found for Biology Major responses and UW-Madison seniors overall or Biology Major responses and other UW-Madison biological science, agriculture, and pre-health majors. UW-Madison Biology Major responses were in-line with biological science, agriculture, and pre-health majors at other public research universities (AAU). No changes were made as a result of this assessment. Recommendations to improve student learning will be formed in coming years when both direct and indirect assessment results are available.

The BMPC assessment subcommittee drafted a “Biology Major Scientific Writing Rubric” to directly assess final academic products of juniors and seniors, including research posters, senior theses, capstone summaries, final papers from courses, UW Bookstore and other award submissions, and Hildale proposals. Direct assessment results will be reported in the 2019 annual assessment report.

The BMPC is looking for avenues for leaders within industry, business, government, or non-profit organizations to become involved in offering advice and perspectives on the program and the curriculum. Alumni of the major are in prime position to offer this kind of useful advice and perspective. The BMPC along with Biology Major staff are working to increase communication with alumni to identify and cultivate leaders and advocates for the major. Alumni relations are discussed in the Career Services and Post-Graduation Outcomes section of the self-study.

#### **D. Recruiting, Admissions, and Enrollment**

The biological sciences, across more than 20 majors, continue to be one of the most popular and growing areas of study at UW-Madison for undergraduates. The Biology major uses faculty and staff from multiple departments and serves the need for a cross-disciplinary major for students interested in a broad biological science major and those who have not yet identified a specialized branch of biology for their major. Over the past ten years, head counts in the Biology Major have ranged from approximately 1100 to

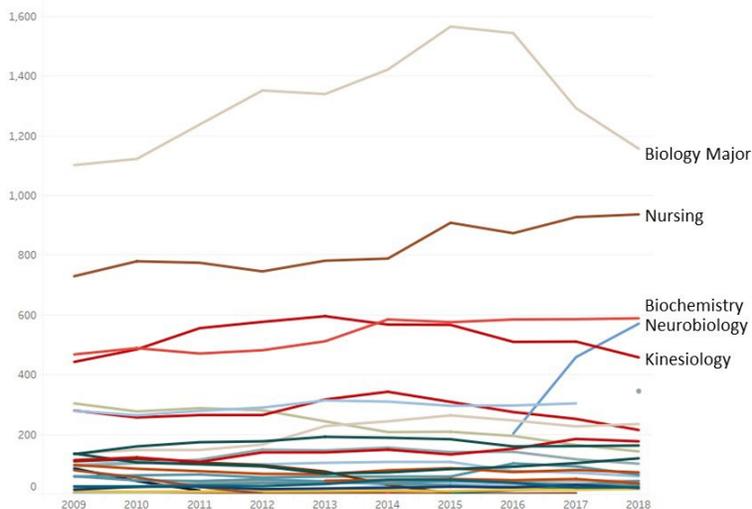


Figure 1: Enrollment in Bioscience Undergraduate Majors.

1500 students (Figure 1). This reflects the growing popularity of biological sciences in general, but also the success of the Biology major (which was only established in 1999). From 2010 to 2015 the Biology major experienced massive growth - a 40% increase in the number of declared Biology majors. In addition, over that same period of time the Biology Major has had an approximate range of 100-600 more declared majors than its next most populous major in the biological science major on campus. In one recent shift, the Neurobiology major was established in 2016 as an undergraduate major separate from the Biology major. The Neurobiology named option in Biology suspended admissions effective Summer 2016 and will be discontinued effective Fall 2019. Between 2016 and 2018, the number of declared Biology majors decreased by 387 while declared Neurobiology Majors reached 571. With this reorganization, the Biology major is back to the size it was ten years ago. The Evolutionary Biology named option, which started in 2008, has increased enrollments to approximately 25 students. Enrollment in the Plant Biology option has had a slow start in its first five years. See Appendix A: First 5-year Review of Plant Biology Option for details. As another notable trend, students in CALS are now the larger cohort of juniors and seniors in the Biology major (2009 to 2018: 347 to 494 for CALS, 523 to 386 for L&S). The Biology major remains, by far, the largest biological science major on campus and one of the three largest undergraduate majors at UW-Madison, signaling impressive program strength and a continued need for campus resources.

### Diversity:

The advising staff have been the primary drivers of diversity enhancement efforts. Advisors attend trainings and conferences regarding inclusion of traditionally underrepresented students in biology. This in turn has allowed staff to improve their own advising practices, to become more inclusive and to become more aware of issues that confront students from traditionally

underrepresented groups. In addition, members of the advising staff have been able to serve on the CALS Equity & Diversity Committee and attend events such as the Summer Collegiate Experience lunch and the Posse Program welcome breakfast.

Diversity enhancement efforts appear to have been successful. According to data gathered by Academic Planning and Institutional Research (APIR), the percentage of targeted minority students currently in the Biology Major is larger compared to the percentage in the general population of UW-Madison undergraduates and the Biology Major has been graduating a greater percent of targeted minority students than the university at large since 2015 (Figure 2). The Biology major also serves and graduates a larger percentage of women than in the general population (Figure 3). This is typical of biological sciences, in contrast to other STEM fields. The following graphs created using APIR data illustrate that increases in targeted minorities and females are trends that has been increasing over time.

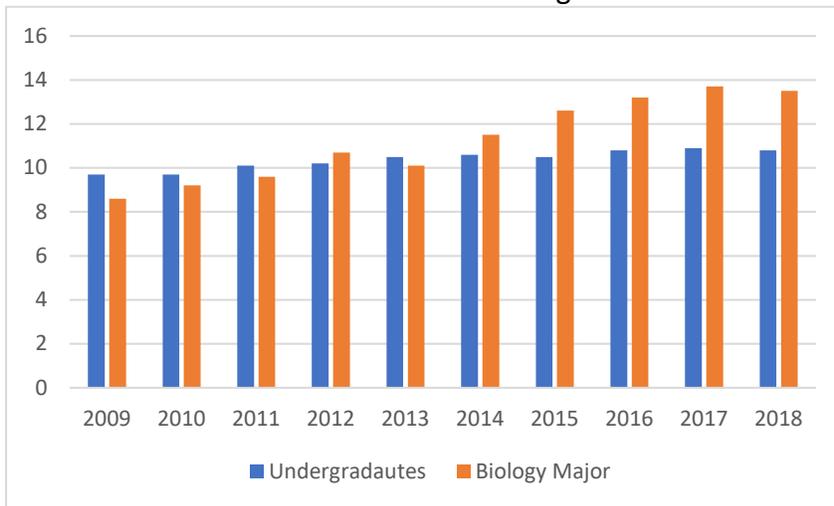


Figure 2: Percent of Enrolled (Degree-Seeking) Targeted Minority Students

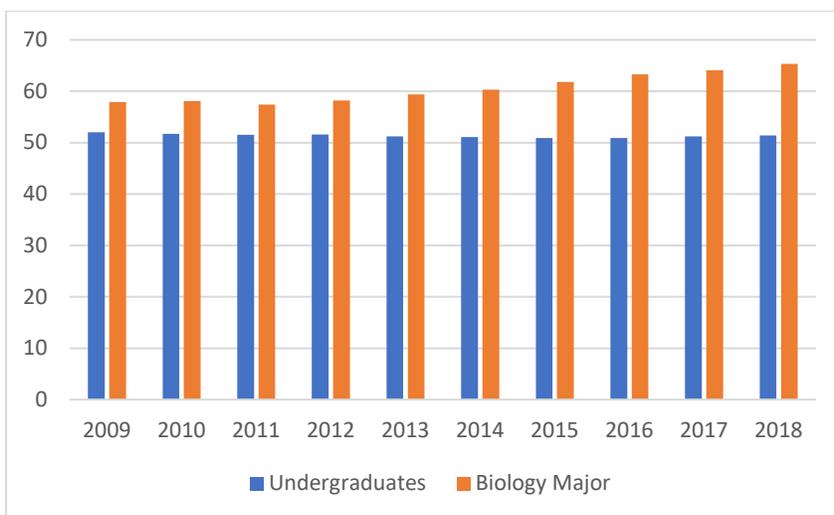


Figure 3: Percent of Enrolled (Degree-Seeking) Women

## **E. Advising and Student Support**

Four student services coordinators and a student services program manager provide advising to Biology Major students. Student services coordinators are typically assigned around 300 students. The student services program manager is assigned half as many students to provide time for administrative and supervisory duties. Students are encouraged to meet with their advisor once a semester. Biology Major advisors provide advising by phone, email or appointment in the Microbial Sciences Building, at SOAR, and at events like the Majors Fair. Advisors use the Advising Gateway and the Advisor Notes System to document advising contacts and coordinate advising with other units (e.g. Cross-College Advising Service, L&S Academic Advising Services, CALS Academic Affairs, Center for Pre-Health Advising). From 2013-14 through 2017-18, the Biology Major advising team averaged over 3500 documented advising contacts per year in the Advisor Notes System. The most common reasons to see an advisor were course selection, major declaration, and designing a 4-year plan.

Students are assigned to an advisor alphabetically by last name. The alpha sort is reviewed and adjusted yearly to restore parity in ratios of advisors to students. Advising transitions are announced in the weekly newsletter and on the website. In the case of a re-sort to balance assignments, students nearing graduation are allowed remain with their current advisor. Students may request reassignment to another advisor at any time if the advising match is not a good fit. Changing advisors is rarely requested.

The Biology Major has experienced several advising transitions since 2013 due to staff leaves, retirements, and promotions to other offices on campus. (One student services coordinator retired, and three student services coordinators and one program manager accepted new positions at UW-Madison.) Each transition was handled smoothly with other advisors temporarily accepting additional advisee assignments and participating in the hiring process. Having an advising team, rather than one or two individual advisors, was key to continuing strong student support and effective training of new advisors in a large cross-college major.

In addition to an assigned academic advisor, all students enrolled in named options are assigned to a faculty advisor. These faculty advisors do research in areas closely aligned with the named option and are active in supporting the curriculum of the named options. Biology Major (no option) students are also offered the opportunity to be assigned to a faculty advisor. Faculty advisors are drawn from a pool of volunteers in the College of Agricultural and Life Sciences, Letters & Science, School of Medicine and Public Health, and the School of Veterinary Medicine. Twenty-eight faculty members are currently accepting Biology Major (no option) advisees. Faculty advisors serve a mentorship role providing guidance on research and graduate school preparation.

The demand for faculty advising has been relatively low for Biology Major (no option) students in recent years. However, the Biology Major Program Committee supports continuing faculty advising. We feel that if faculty and students were better educated about the advantages of such relationships, more would be interested. We will take a first step in that direction by

outlining best practices for Biology Major faculty advisors. We will present these best practices to both students and potential faculty advisors to clarify the faculty advisor role. We have considered moving away from formally assigning faculty advisors for non-option students in the Student Information System to instead providing a list of friendly and knowledgeable biological science faculty available for consultation with any Biology Major student. In order to expand this list, the Biology Major will need to launch a faculty recruitment effort in the near future.

Biology Major staff advisors play other important roles, apart from advising students, in the university community. Biology Major staff advisors serve on a number of committees (Campus Pre-Health Committee, Council on Academic Advising, CALS Scholarship Committee, CALS Equity and Diversity Committee, CALS Scholastic Policies and Actions Committee) and the Bioscience Advising Team, as well as teaching in Counseling Psych 125: A Wisconsin Experience Seminar. Committee service along with regular updates and opportunities through the Office of Undergraduate Advising, the College of Agricultural and Life Sciences, and the College of Letters and Science provide many training and professional development opportunities. The Biology Major supports further professional development by providing funds for two advisors to attend off-site professional conferences such as NACADA: The Global Community for Academic Advising each year.

Other informational resources are offered to the students through the Biology Major website and a weekly newsletter. The advising page on the website (<https://biologymajor.wisc.edu/advising/>) shows advisor contact information and links to schedule appointments. Text at the top of the page introduces common advising topics and links to Office of Undergraduate Advising expectations about advising. The resource page (<https://biologymajor.wisc.edu/resources/>) provides links to career, graduate/professional school, internship, study abroad, scholarship, transfer, and tutoring information as well as four year plans for the major and each named option. The website is reviewed through regular use in advising and updated as new information becomes available.

A weekly newsletter, which is sent by e-mail to all declared Biology Major students during the fall and spring semesters, serves as a vehicle for direct communication of information relevant to all students in the major. The newsletter answers common advising questions and provides information on advising access, application and academic deadlines, new courses in and outside the Major, scholarships, clubs, seminars of interest, workshop and conference opportunities, study abroad fairs, and career information such as career and internship fairs. In exit surveys, a majority (61%) of students in the Major accessed the Newsletter and found it useful or sometimes useful. The newsletter open rate varied between 53% and 24.5% in 2017-18 and between 55.9% and 39.6% thus far in 2018-19. This open rate is generally higher than the 25.88% average for institutions/degree programs (<https://www.mediapost.com/publications/article/317556/higher-education-email-open-and-click-rates-rose-i.html>). Past newsletters are available to read on the website (<https://biologymajor.wisc.edu/newsletters/>).

The impact of advising is assessed indirectly through open text answers to the exit survey question, “Do you have comments about the assistance you received from the Biology Major staff advisors?” Comments have primarily been positive and often call out assistance from a specific advisor.

*“My satisfaction with the major is highly attributable to my advisor ... She was my mentor, supporter, and cheerleader. She guided me in course selection, relevant extracurriculars, and research opportunities. I was extremely grateful for her support.”*

*“... an amazing advisor! She was always attentive, available, quickly helped me to accomplish the objectives of the appointment, and overall the best advisor I've ever worked with.”*

*“The staff is well-trained and helpful. They had my interests in mind when recommending future plans.”*

The exit survey will be updated soon to more closely align to major learning outcomes and the Guiding Principles for Academic Advising. We are also exploring campus resources that will allow us to more directly assess the impact of advising. Time to degree for Biology Majors has been under 4 years starting with the 2014-15 academic year (see Degree Completion and Time to Degree section). We believe this is due in large part to increased resources provided during the administrative reorganization of the major in 2013, which allowed for a more favorable student to advisor ratio (300:1 after 2013 vs. nearly 600:1 before 2013). Advisor performance reviews are conducted in accordance with human resources policies for Performance Management. Starting in 2018, reviews are recorded electronically in the Performance Management and Development Program (PMDP).

## **F. Program Community and Climate**

Climate and a sense of community in an academic program are difficult to define and difficult to assess directly. For some students, it involves developing a sense that they belong to a cohort with shared experiences. Other students develop a sense of belonging through demonstrations that they are valued and supported as individuals regardless of identity. In this section, we describe elements of the program that provide the latter, and a discussion of present and future efforts and the difficulties of providing the former in a large diverse major.

Advisors maintain contact with the students from the day that they declare the Biology Major. In many cases, they connect with students from their first full day on campus through the Student Orientation, Advising, and Registration program (SOAR). Students who declare Biology during SOAR are subsequently contacted by the Biology advising team to confirm schedules and welcome them to UW, supplementing similar outreach from SOAR staff from the College of Letters and Science and the College of Agriculture and Life Sciences. Major advisors are also present at the annual Majors Fair in Union South.

The Biology advising staff continues outreach to students using methods like midterm grade checks and deadline reminders, and direct interactions like through appointments, phone calls and emails. Each student receives a weekly newsletter from the program throughout the academic year (see Advising section). Both the College of Agricultural and Life Sciences, and the College of Letters and Science give individual trainings for advisors on policies and resources that positively impact advisor-advisee relationships and aid in student retention and matriculation. Exit surveys indicate that the vast majority of students (93%) directly contact the advising staff one to two times per year.

Students in the named options are in a smaller cohort and have greater opportunities to interact with faculty and develop a set of shared experiences. Each option requires a one credit seminar that serves as a unifying experience for students in plant biology, evolutionary biology, and neurobiology. Each seminar is organized through a dedicated faculty group (e.g. the Crow Institute organizes Biology/Genetics 522: Evolution Seminar Series). Students outside of the named options may take these seminar courses as a part of their intermediate/advanced biology requirement, but few chose to do so.

Students in the major (no option) have diverse interests and the numbers of these students have precluded us from developing a similar, single unifying course for this cohort. If instituted as a requirement, this would necessitate a format appropriate for the 300-400 students per year of the senior class cohort. Since the Major does not control any departmental resources, it is difficult to see how this could be accomplished without the addition of faculty and TA FTEs or fiscal rewards for participating instructors. This problem could be partially dealt with by encouraging the development of an array of new named options, each running an option-specific seminar. However, new options come with increased administrative costs (Guide and Lumen updates, DARS encoding and updating, record keeping), make advising increasingly difficult, and require a considerable investment of faculty time (oversight and seminars). Although we have entered into discussions with several interested groups of faculty in recent years, only the group proposing the Plant Biology named option have followed through to establish a new named option.

A sense of community can also be based on extracurricular and social, rather than academic, interactions. For example, for many years, the Neurobiology named option (now the Neurobiology major) organized “Neuro Night”, organized around a neurobiology theme, with food provided by the program. For the past few years, the Biology Major has held a reception before the spring graduation, where graduating students and their parents can gather to celebrate their accomplishments. This has been a great hit: the students seem truly excited to meet Bucky, pick up a Biology Major mug, view each student’s favorite experiences slide, and introduce their advisor to their parents.

While we would like to offer more community-building activities of this kind, large student numbers have consumed considerable advising and administrative resources, and we lack the financial resources for increased programming. Because our students have such diverse interests, it is also difficult to imagine that any single extracurricular club, workshop or seminar

series could satisfy their needs. Instead, we have looked to the rich array of campus programs and organizations to provide valuable extracurricular experiences. We promote these by connecting students to them either through direct advising or through the Biology Major's website (<https://biologymajor.wisc.edu/>) and weekly newsletter. Campus programs of interest to Biology majors include various pre-professional groups, the Beta Beta Beta Biological Honors Society, Undergraduate Research Scholars, the BioCommons run by WISCIENCE and Steenbock Library, and the BioHouse Learning Community sponsored by WISCIENCE, L&S and CALS. Many students interact with their biological science peers in Tutoring & Learning Support Services and the student-run Peer Learning Association.

Students are also directed to organizations that serve particular populations, such as International Student Services, Career Exploration Center, and student organizations that focus on STEM, women in STEM, POC in STEM, Women in Medicine, Women in Veterinary Science, WOC in Medicine, Center for Equity and Diversity, Campus Women's Center, Wisconsin Black Student Union, Multicultural Student Center, Asian American Student Union, Hmong American Student Association, and Gender & Sexuality Campus Center (LGBT Campus Center).

Finally, many students in the Major have the opportunity to connect to the campus research community through faculty and their research laboratories. A subset of students chose and interact with faculty advisors (see Advising Section). Other students join faculty lab groups either in early years as part of the Undergraduate Research Scholars or other programs or through the Introductory Biology 152 course's Independent Projects. As juniors and seniors, many students join labs to gain research experience and/or fulfill Capstone or Additional Lab or Field Research Experience requirements. These students interact extensively with faculty, graduate students and research staff in a laboratory or field setting.

#### **Diversity in faculty and staff:**

Biology Major has no faculty appointments, and thus relies on the efforts of departments with faculty and courses that are part of the Biology major to increase faculty diversity. Faculty and staff diversity, particularly from underrepresented groups in the field, has increased in many of the departments that participate in the Biology major.

Staff hiring is coordinated through the Department of Bacteriology, which acts as the fiscal and administrative home for the Major's staff. Positions are advertised through the central campus position vacancy listings. Search committees have included faculty and staff from multiple colleges and have been formulated to maximize the diversity of voices at the table in hiring decisions. Best practices to ensure unbiased evaluations are discussed at the start of each search.

#### **G. Degree Completion and Time to Degree**

After a dramatic increase in the numbers of Biology majors, followed by a decline coinciding with the implementation of the Neurobiology Major, the number of Biology majors seems to have stabilized. The 5-year average and last few years' numbers seem to indicate that we will

typically graduate approximately 500 students each year (Figure 4). The final Neurobiology Named Options will be awarded in Summer 2019. Beginning in 2019-20, we expect to award 15-25 named options per year (Figure 5).

### Biology Degrees at UW-Madison

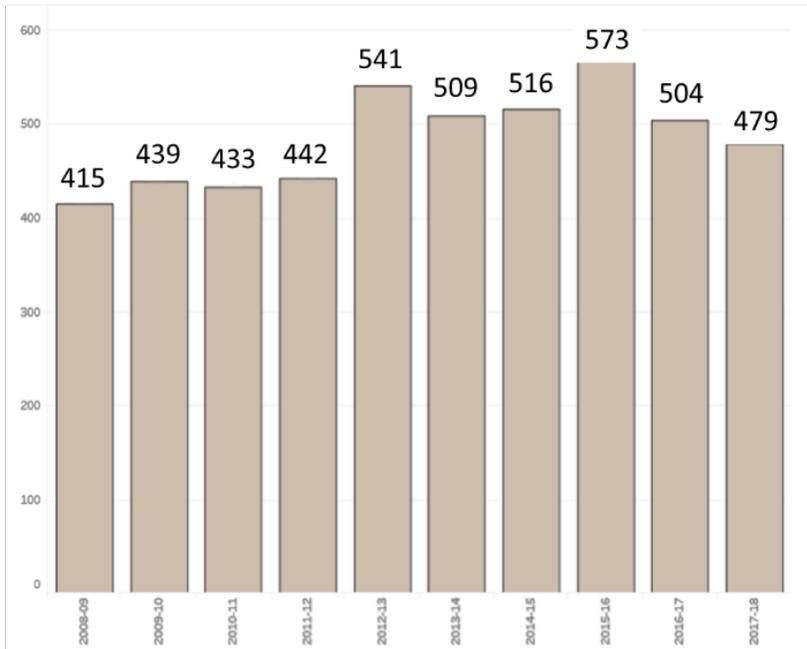


Figure 4: Biology Major Degrees Awarded

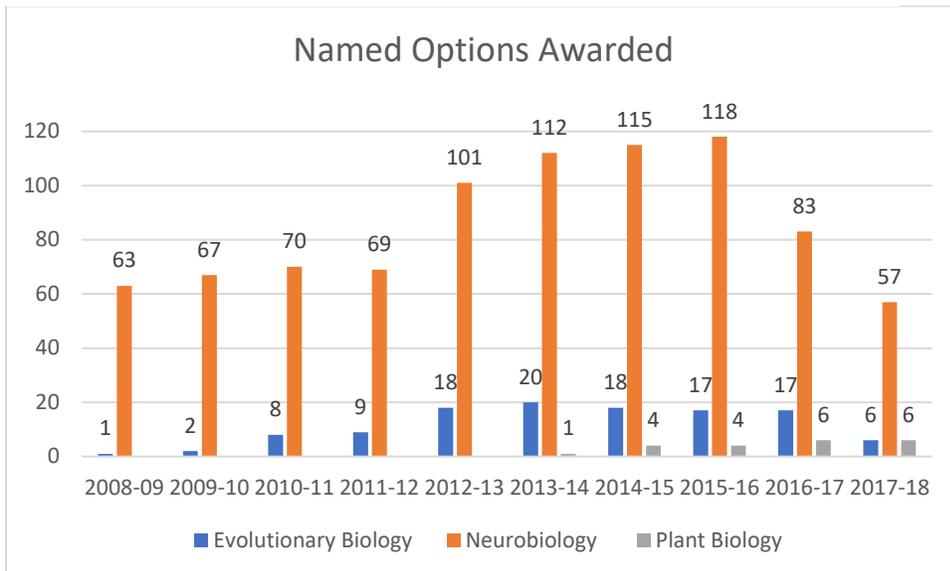


Figure 5: Biology Major Named Options Awarded

The time to degree (TTD, elapsed calendar years from entry to degree for undergraduates entering as full-time new freshman) was evaluated for the Biology Major and compared to a grouping of all campus majors and a grouping of biological science majors on campus (Table 1). Since 2008-2009, Biology Major TTD has been consistently lower than the average for undergraduates at UW-Madison and, with the exception of 2015-2016, has also been lower than the average for biological science undergraduates at UW-Madison. Time to degree was variable between CALS and L&S biology majors, but has stabilized, and has been equal or nearly equal since 2014-15. TTD was also variable among named options but leveled off as the option curricula matured (Figure 6). TTD for all Biology majors has been consistently around 4 years since 2011, with further drops (to 3.83 years) in the last few years. TTD has declined across campus since 2013, which can be attributed to several factors, including increases in the number of Advanced Placement credits students enter with, and campus-wide efforts to eliminate curricular bottlenecks. In general, Biology majors are graduating sooner than their peers in other biological science majors and across campus.

Table 1: Time to Degree; Comparison of biology majors to all UW-Madison majors and to other Biological Science majors on campus

Year	Biology majors	All majors	Biological Science Majors
2008-2009	4.13	4.23	4.19
2009-2010	4.05	4.22	4.18
2010-2011	4.00	4.16	4.07
2011-2012	3.94	4.15	4.07
2012-2013	3.99	4.15	4.14
2013-2014	4.00	4.15	4.05
2014-2015	3.88	4.13	4.03
2015-2016	3.93	4.07	3.92
2016-2017	3.83	4.03	3.93

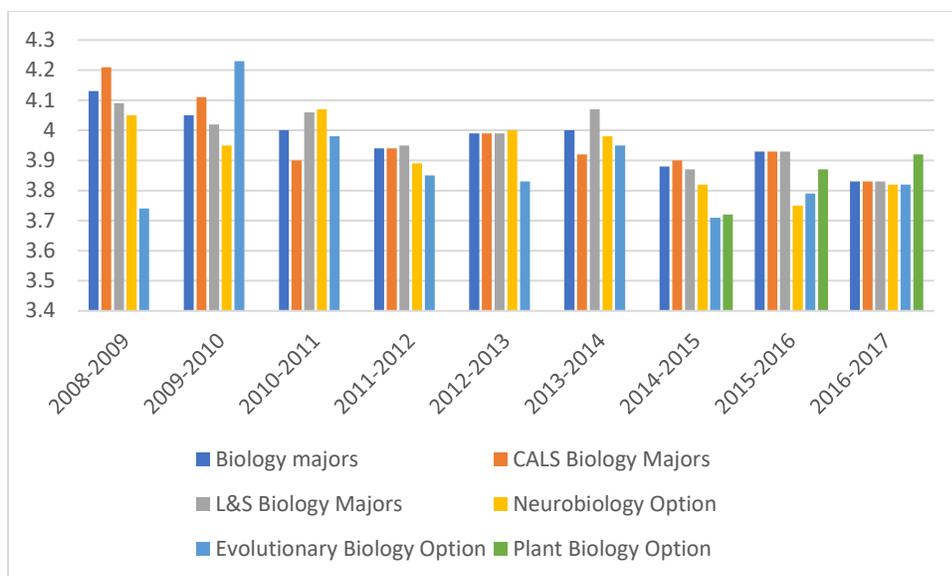


Figure 6: Biology Major Time to Degree by college and named option

Aggregate data from L&S DARS covering a 6-year period, beginning with the 2012 fall semester, indicate that even though the Biology major is one of the larger majors in the university, students in the major are able to complete most core requirements in the semesters and years described in the 4-Year Road Map for the Biology major. This Road Map is designed for students to use as a suggested plan for navigating through the Biology major in a timely fashion (<https://biology.wisc.edu/resources/four-year-road-map-biology-major/>). For example, students are encouraged to complete their Introductory Biology courses in the fall and spring of the second year. Data compiled from the 6-year period from fall 2012-spring 2018 indicate that 86% of students were able to complete this crucial requirement during their second year. This ability for students to enroll in classes when it is suggested to do so over their 4-year career indicates that the size of the Biology Major has not detracted from our ability to ensure adequate course access for our students for compulsory requirements and on-time graduation rates. The data presented here illustrate that the Biology major, in association with other units and faculty across campus, is able to successfully serve students at the University of Wisconsin-Madison.

### Improve Progress to the Degree:

There do not appear to be curricular bottlenecks in the Biology curriculum at present; however, several factors may limit further declines in TTD. First, we note that if the general trend of increasing numbers of students choosing to pursue CALS (versus L&S) degrees continues, access to Capstone classes may become problematic. Many students prefer to fulfill their CALS Capstone requirement by taking approved Capstone courses rather than through Independent study experiences. However, because Biology does not control any FTEs, we must rely on others to provide these opportunities to our majors. In many cases, Biology majors may not have the necessary prerequisites or seats may not be available in the Capstone courses designed for other CALS majors. To counteract this, the Biology Major Program Committee has worked with

instructors to identify other courses that offer Capstone-suitable experiences and shepherd them through the Capstone approval process. In the last few years, permanent Capstone approval has been granted for several additional courses, some taught by instructors within CALS (Plant Path 315: Plant Microbiomes, Genetics 527: Developmental Genetics for Conservation and Regeneration) and others taught by instructors from outside of CALS (ANAT&PHY 435: Fundamentals of Human Physiology, Bmolchem 504: Human Biochemistry Laboratory). We are also highly dependent on seats in two L&S courses (Zoology 511: Ecology of Fishes Lab and Zoology/Botany/F&W Ecol 460: General Ecology) that do not, at present, have permanent Capstone approval status. We will be working with instructors of those courses to secure permanent approvals before the current, limited approvals expire in summer 2020.

Other factors that may contribute to longer times to graduation are more difficult to address. A large number of our students are interested in health professions and are trying to satisfy specific professional school requirements along with the requirements for the Biology degree. There are currently not enough seats available in some high demand courses (e.g., ANAT&PHY 335: Physiology and ANAT&PHY 435: Fundamentals of Human Physiology). Although some students may be able to take another course to satisfy specific professional school requirements, many do not have that flexibility. These students may purposefully delay graduation in order to meet professional school requisites while at UW-Madison.

#### **Equity Gaps:**

As mentioned earlier in D. Recruiting, Admissions, and Enrollment, the percentage of targeted minority students that have declared a Biology Major is currently larger than on the campus as a whole. Here we show (Figure 7) that the percentage graduating with Biology degrees is also higher than the university at large. The same is true of women degree recipients (Figure 8). Recognizing that good advising plays a role in reducing equity gaps, the Biology Major has actively encouraged participation of advisors in a variety of training and outreach events. Best practices include encouraging students from underrepresented backgrounds to make an appointment early to discuss upcoming terms and requirements. The early email alert's goal is to minimize a cultural capital gap in navigating UW.

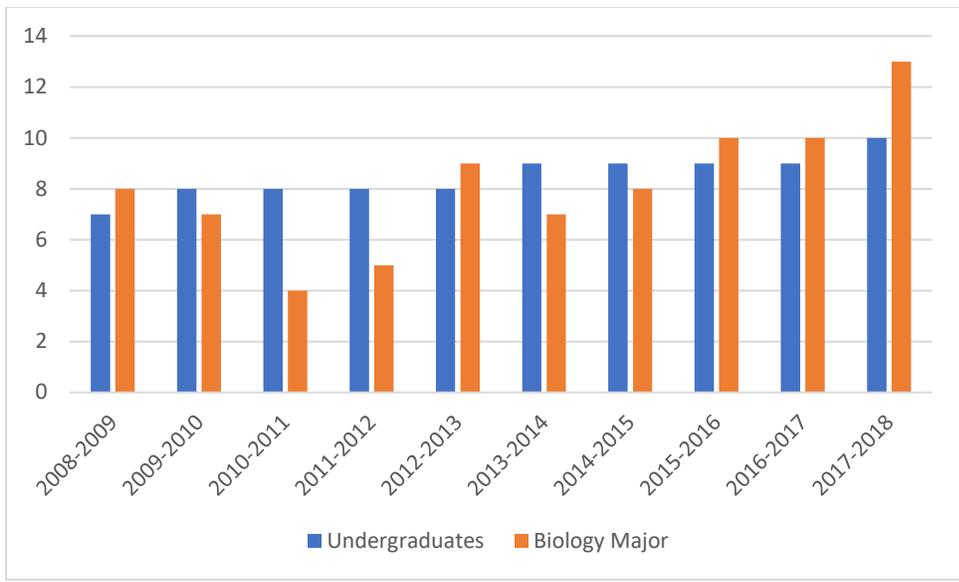


Figure 7: Percent of Targeted Minority Degree Recipients

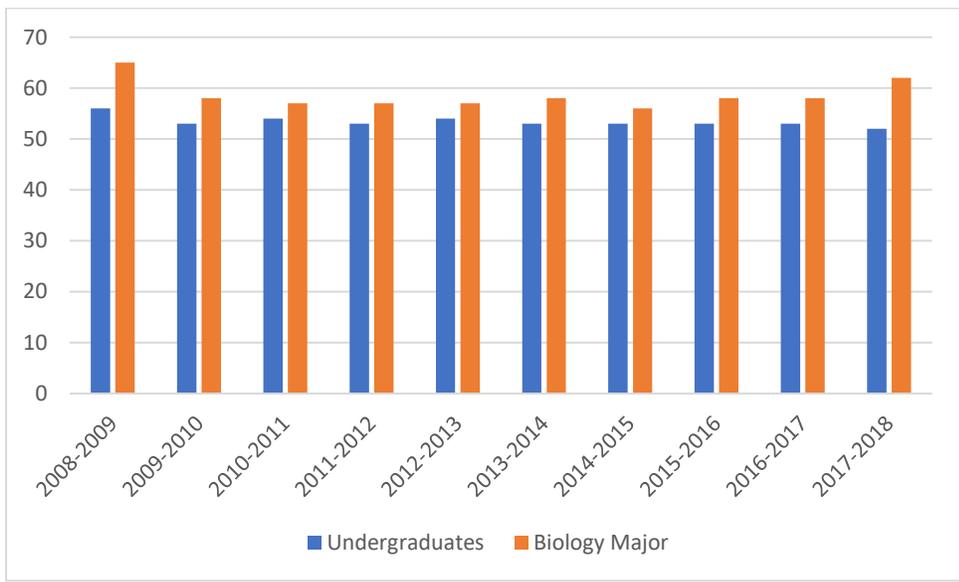


Figure 8: Percent of Women Degree Recipients

**H. Career Services and Post-Graduation Outcomes**

Discussion of career plans is a routine component of face-to-face advising provided by the Major’s staff and faculty. Advisors assess student needs and refer students to the career advisors on campus. The Biology Major website resources page includes links to the College of Agricultural and Life Sciences Career Services, Letters & Science Career Services (SuccessWorks), and the Center for Pre-Health Advising. There are also guidelines and links to

internship opportunities (<https://biologymajor.wisc.edu/resources/>). News on specific career or internship opportunities and workshops are included in most of the weekly newsletters that are emailed to every declared Biology Major. While we do not have data on how many students click through to these resources from our website, our exit survey indicates that 87% of graduates visited the website and found it useful or sometimes useful.

Other data from exit surveys indicate that the Biology major is doing a good job fulfilling the goal of supporting students “. . . interested in post-graduate careers in any biological science or health profession.” With about 700 Biology Major graduates reporting from 9 semesters of exit surveys, approximately 32% planned to go directly on to graduate or professional school, another 18% planned to continue their studies after working for a year or two, and 16% planned to take jobs related to their Biology degrees. Thus, a total of 66% of Biology graduates intended to make direct and immediate use of their Biology degrees. Of the remaining 34% of Biology graduates, 18% intended to take some time off before pursuing their careers, 8% had no plans, and 8% planned to pursue careers not related to Biology. This suggests that more than 50% and perhaps as many as 90% of graduates will draw on their biological expertise in their future careers.

Exit surveys indicate that the Biology Major is doing a very good job preparing students for their careers. With approximately 350 students reporting over nine semesters, 95% reported feeling well-prepared for their intended careers (20% “very well”; 51% “well”; 23% “moderately well”), and 99% said they had had opportunities to apply their classroom knowledge in settings such as laboratory classes, research and internships. Seventy percent reported that they had been able to evaluate the diverse professional opportunities for students who studied Biology. While these numbers are high, the latter suggests there is room for improvement in prior exposure to and thus evaluation of alternative careers.

The program’s second and third learning outcomes are to “Demonstrate practical skills of a professional biologist including: problem-solving by engaging the process of science; written and verbal proficiency; laboratory skills; quantitative analysis skills; and teamwork skills.” and “Engage and make broader connections to other scientific disciplines and society.” In exit surveys, 91% of Biology Major graduates reported that they had learned to analyze and construct arguments, define and solve problems, and understand and apply scientific reasoning. 89% also said they had learned how to use data and research methodology in their critical thinking, and 79% said they had learned both statistical and research skills used in the biological science. In addition, 86% reported that they had learned to communicate their ideas in clear, organized, and compelling ways, and 92% reported having gained an appreciation for the contributions Biology makes to society. We note that problem solving, data analysis and communication are fundamental to most careers, suggesting that the Major is also providing strong training for non-biological careers.

#### **Alumni information and outreach:**

Currently, the Major does not track the career progression of its graduates. Better information from alumni on career and satisfaction outcomes would be helpful. We hope to couple surveys

with other outreach activities, such as a yearly Major newsletter for alumni and other types of publicity and fundraising activities. We recognize that alumni can be important mentors for current students and we hope in the future to partner with CALS Career Services and the Letters & Science SuccessWorks to organize additional career events of particular interest to Biology majors.

#### **I. Overall Analysis of the Self-Study and the State of the Program**

The Biology Major is a strong and healthy academic program that is effectively serving the needs of a large number of students at the University of Wisconsin-Madison. It particularly attracts students seeking broad and rigorous training in biology coupled with flexibility in their academic plan. The transition to a new administrative structure, coupled with the input of additional resources, has largely solved previous problems related to the rapid growth of the major over the past 10 years. The increase in FTEs devoted to advising has been particularly crucial.

With the establishment and rapid growth of the new Neurobiology Major, the pressure on the Biology Major Program to accommodate ever increasing numbers of students has ceased. We view this as a positive change. We are currently graduating about 500 students per year, and we expect this to continue.

The Biology Major Program will be 20 years old soon, and with stabilized student numbers, may be poised to move into a more mature phase. In the new few years, we would like to devote more time and attention to establishing communication with our alumni and to coordinating with campus offices to offer increased programming for our students. The Biology Major Program Committee will continue to manage our cross-college curriculum, assessment, advising, and communications with an eye on student learning and achievement, balanced with a desire for cohesiveness and recognition of administrative constraints.

## Appendix A: First 5-year Review of Plant Biology Named Option

Prepared by Prof. Irwin Goldman, for the Plant Biology Named Option Coordinating Committee

The original proposal to create a new named option in “Plant Biology” arose from the faculty and departments that study plant science at UW-Madison. This group acted on the Biology Major Review Committee’s recommendation that options under the major offer more and better faculty-student interaction to students completing UW-Madison’s largest undergraduate major.

We also felt that the proposal presented a new opportunity to reach students who may be interested in plant science, but who may not be ready to specialize in any of the current undergraduate majors focused on distinct areas of plant science (Agronomy, Botany, Horticulture, and Plant Pathology). The Plant Biology option offers students a more synthetic approach that aligns with the “general biology” approach of the over-arching Biology major.

The goal was to connect Biology Majors with the world-class plant science faculty across campus and offer an option for those students to pursue focused study in this area of biology. We further recognized that some biology majors may have an interest in plant science but may take very limited coursework in this area during their undergraduate work. We also appreciated the notion that providing options or tracks within the Biology Major may provide students with a “home within the major” that could increase the quality of their learning experience on our campus.

We are also aware that multiple departments (Agronomy, Horticulture, Plant Pathology, Botany) offer majors for students interested in plant science. However, the undergraduate enrollment in four departments does not generally exceed a total of approximately 125 students. We felt we had the capacity to add more students to our teaching and advising efforts and, perhaps more important, to serve the needs of students in the Biology Major who may find a plant science option an excellent way to gain more focus and direction in their studies.

Consistent with the expectations for the other named options, the requirements defined a “Plant Biology” pathway through the general Biology major requirements. Developers of the option considered that it would not be appropriate for students in this program to pursue this option while also completing another undergraduate major in plant science; students were therefore not allowed to combine the more specialized majors in Agronomy, Botany, Horticulture, and Plant Pathology with the Biology: Plant Biology option. In retrospect, this was perhaps one of the reasons the number of enrollees was so low in the program.

A committee comprised of the four Curriculum Committee chairs from Agronomy, Botany, Horticulture, and Plant Pathology constituted the governance committee for the Plant Biology Option. These individuals served two-year terms on the governance committee for the Plant Biology Option. In the second year of their two-year term, and in each succeeding year, two of the four departments supplied a second faculty member to join the governance committee, resulting in a total of six faculty in any given year serving on the governance committee after

year 1. The committee was chaired by one of the Curriculum Committee chairs, and the chair term was two years. This committee received requests for course additions / deletions and served as a sounding board for instructional and student issues related to the Plant Biology Option. When the University Academic Planning Council endorsed a change in the governance structure for the Biology Major through the creation of a Biology Major Program Committee (BMPC), a Plant Biology representative began serving on the BMPC.

We created a new course called *Frontiers in Plant Biology*, which has been taught twice so far and is also now being taught in the Spring semester, 2019. Students selecting the Plant Biology Option are required to take this 1-credit seminar at least once. This seminar class is intended as a unifying academic experience for the Plant Biology Option. Its larger objective is to mediate substantive intellectual interactions among both the students and the faculty in the program. Two faculty members co-teach each offering of *Frontiers in Plant Biology*. The instructors choose a topic for the semester from a current area in which they have interest and expertise. (Sample topics might include: Physiology of plant stress response to droughts and floods; Current topics in sustainable food production; Ecological and agronomic roles of endophytic microbes; Perspectives on genetically modified plants; Understanding the functions of plant structure). The teaching faculty present initial foundational material and assemble a list of assigned papers in the topic area. Each week one or two students present background material and lead a discussion on a current article from the peer-reviewed literature or other relevant source material. This course is an active, participatory learning experience. The course's learning outcomes are that students will: 1) acquire depth of knowledge in a specific sub-discipline; 2) develop skills in oral presentation of plant biology research; and 3) have advanced skills and confidence in critical scientific analysis.

### ***Evaluation***

***a. Determine whether the goals and objectives as stated in the original program proposal were met and evaluate if the program is meeting standards of quality that are expected based on the original proposal.***

We anticipated a demand of about 75-100 students initially; however, enrollment in the program has been very modest, never exceeding 7 students in any semester (Figure 1). At present only a few students are enrolled in this named option.

We do not know all of the reasons why enrollments were so low in this option during this period of review, but we suspect that part of the reason has been a lack of promotion of this option and a lack of marketing by the faculty and staff of the plant science departments. As enrollments continued to drop in our academic departments during the period of review, there were no obvious efforts made to increase them, and thus it is not surprising that few efforts were made to recruit additional students into this option. The majors of all four of the founding departments are all still quite low and have remained so throughout the period of review. Some of the low enrollment in the named option may have been due to a limited understanding of this option by the plant science teaching faculty and staff. And some may have been due to low

student demand for a strict plant biology program. Students are able to study in plant science programs in our department, which, in a number of cases, have fewer requirements and greater flexibility than the Plant Biology named option, and so it is possible that the cohort of students interested in a plant science undergraduate program sought these more flexible majors instead of the option.

A student pursuing a Bachelor of Science with a major in Agronomy, Horticulture, Plant Pathology, or Botany could obtain a similar set of courses as a student pursuing the proposed option. However, for three of the departments, most undergraduate majors would be completing coursework that is not as strongly oriented toward basic-science as that which is proposed for this option. The Plant Biology named option represented a new pathway toward a plant science education at UW-Madison; one that is nested within the Biology Major and its attendant rigor, but with a specialized track that allows students to pursue more focused studies in plant science and to become acquainted with faculty in this field of science. For various reasons, we were not able to find students who were interested in this sort of an academic experience.

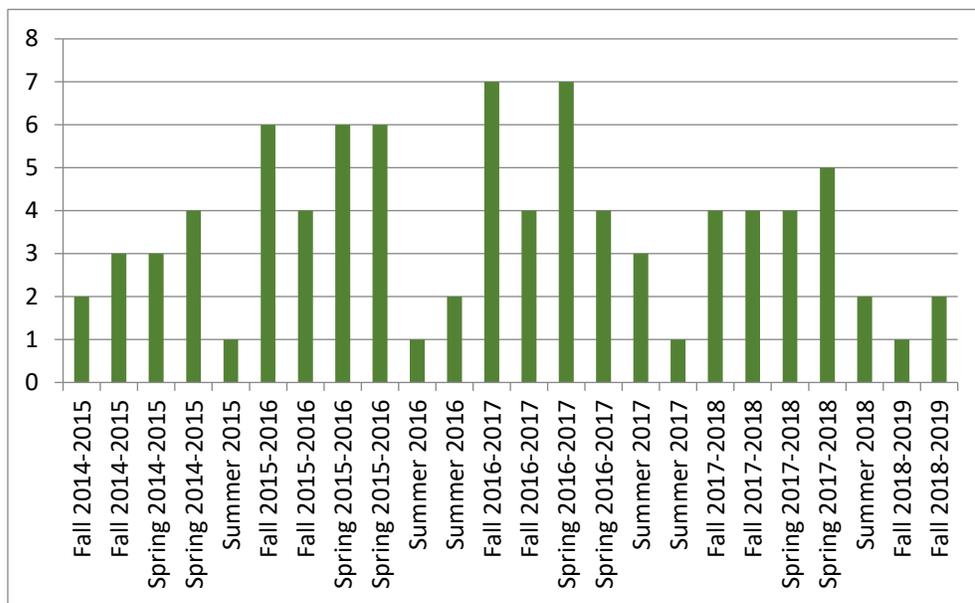


Figure 1. Students enrolled in the Plant Biology option of the Biology major from 2014-present

***b. Confirm that the program is important to be delivered at UW-Madison and understand the program’s relationship to other programs at UW-Madison. Are other programs positively or negatively affected? Are connections with other programs as planned in the original proposal developing as envisioned?***

We believe that a plant biology / plant science curriculum is of critical importance to UW-Madison, and indeed several are offered from Agronomy to Horticulture to Plant Pathology to Botany. We do not feel that the Plant Biology named option realized the potential for such a

curriculum. At this time, the five departments of Agronomy, Horticulture, Plant Pathology, Entomology, and Soil Science have formed a collaborative to explore creation of a new undergraduate major in agricultural ecosystems, and we believe that the locus of a plant science program may fit best within this new major. This effort is part of the CALS Reorganization efforts that began in 2017. Importantly, the collaborative would phase out five low-enrollment undergraduate majors in favor of a new, dynamic multidisciplinary major in agricultural ecosystems with tracks in key disciplines.

The new collaborative would develop a major in agricultural ecosystems (see figure below) that would include a plant science track.



*Proposed **Agricultural Ecosystems Collaborative**, comprised of four current CALS departments plus the likely participation of the Department of Agronomy, who will form the core of a new, shared undergraduate major in Agricultural Ecosystems.*

***c. Determine if the resource implications of continuing the program are appropriate.***

We do not believe that there is a strong argument for continuing the Plant Biology named option in the long-term. However, students may be best served by continuing the Plant Biology

named option until the new Agricultural Ecosystems major, including a plant science track, is in place.

***d. Offer the program faculty, the dean(s), and/or provost any advice for program improvement and summarize any actions for follow-up or attention.***

We recommend that as part of the phase out of the five majors in CALS that are connected to the collaborative described above, we also include a phase out of the plant biology option in the Biology Major.